Hot Iron

Issue 11 *"Journal of the Constructors Club"* **Spring 1996**

Contents

- Taunton Updates
- Diary Dates
- Twin VFOs
- Workshop practice
- Sig Gen Design

Editorial

Earlier this afternoon, as I was pointing one of our stone walls on the farm, I was wondering what to put in this issue of Hot Iron as I didn't remember there being very much in the file of contributions. I am pleased to report that in fact the file contained several contributions and this issue should be somewhat more interesting for not having been all my own material! It really is very important for you to continue with these offerings as I already have to think uncomfortably hard for my own topics! It makes it so much more interesting if there are many contributors so please do continue sending me in your articles, snippets and questions etc.. It is intended to be *your* Club with me doing most of the work! For each issue, I try to have a note on some design type topic and I would love some feedback on what aspects of construction etc. you find troublesome and needing more explanation. I purposely try to avoid the maths of the subject since it is boring and, anyway, I have forgotten that little bit that I did know years ago! By way of example, a later note describes some of the trade-offs in the design of a signal generator - an item that has long been on my project list but which makes slow progress. I would love some comment on priorities.

Tim Walford G3PCJ Editor

Kit Developments

I have already mentioned a **Three Digit Counter** which I am pleased to report is now available. It uses the same counters and displays as the 5 digit one and can also count from DC to over 60 MHz with a typical input sensitivity of about 50 mVolts RMS at 20 MHz. Depending on the setting of a link (or switch), the three digits can either show the KiloHertz value of the input signal or the hundreds of KHz. The former mode is intended for use with rigs where it would show the KHz part of the tuned frequency (the MHz part having overflowed out of sight). This can be used with direct conversion rigs or with superhets having an IF which is a whole number of MHz. The other mode is intended for general use such as measuring a rig or signal generator output frequency with a 'display' upper limit of 99.9 MHz - the circuits are very unlikely to work that fast though! In addition, when used with a superhet, the counter can count either up or down for additive or subtractive mixers; also, a preset of + or - 1 can be applied to approximate for the usual CIO offset of 1.5 KHz from the nominal IF. The 3 displays and segment resistors are all mounted with the logic on the 100 x 80 mm PCB; the display section (25 x 80 mm) can also be cut off remote mounting if required. Price is £37 + £1 P&P.

Experience with the earlier variable CW filter kit showed that it was too sensitive to individual rig layout so I have redesigned it as the **Adjustable CW filter** kit. The good news is that it has the same very high performance elliptic switched capacitor tuneable lowpass filter, with presets for CW and SSB bandwidth. The response is down 79 dB at 1.5 times its set -3 dB frequency corner frequency bandwidth - this makes it almost a brick wall filter!! It now has a separate preset for the frequency of the tone used to modulate the transmitter. This considerably simplifies both the circuits and its method of use. It has semi break-in operation and a Tune facility. Size is down to 50 x 80 mm. It can drive walkman type phones. Price is down to £27 + £1 P&P.

Hot Iron is a quarterly newsletter for radio amateurs interested in building equipment. It is published by Tim Walford G3PCJ for members of the **Construction Club**. Articles on simple theory, construction, testing, updates on kits, questions and suggested topics are always wanted. Please send correspondence and membership inquiries to Upton Bridge Farm, Long Sutton, Langport, Somerset, TA10 9NJ. Tel & Fax 01458 241224 Subscriptions are £5 per year for the UK (£7 overseas) from Sept 1st in each year. Sept 1st 1995.

Taunton Updates

Those of you with Taunton receivers should already be aware that the CD4066 used for IC105 had a spare unused switch section which was originally connected to the positive supply in Issue 4 and earlier PCBs. It transpires this was a bad design decision because it can lead to damaging supply currents at switch on which in turn applied an unwanted high voltage to the associated NE612 IC104 which then also expired! It is advisable to connect the pins 10, 11 and 12 of IC105 to the adjacent pin 13 (RXC) and lead the 12 volt track around this group. Ray Donno G3YBK advises replacing the 4066 when doing this modification as his rig produced some queer results after the mod due to internal damage to the 4066 which was not showing up in normal use. If any of you are having difficulty with this aspect please contact me.

There a couple of other errors in early Manuals; on page 8, C101 needs moving into the table higher up the page to join C102 to make the oscillator work. On page 19, Figure 9, the 30m receiver bandpass filter coils L201 and L202 should be TOKO types 3334 instead of 3335 - customers with these bands have been told. Also C137 appears twice in some early RX parts lists - it should be 10 nF as in the circuit diagram and not 1 µF.

I am please to announce that the **TWO** band plug-in card for the Taunton is now available. It can take **any** two bands in the range 15 to 160m with selection by a front panel switch. I am grateful to Tony G3WUC for assistance with proving this design. He has also been experimenting (using his old single band cards) on getting the rig running on 12 and 10 metres. He has overcome the snag of needing unusual crystal frequencies for 12m by extending the VFO coverage. More details on his progress in a future Hot Iron. The fully equipped 2 band card is £37 or, if you can salvage the parts from two single band cards, the PCB and five relays are £20.

Coker VFO Capacitors

With a little nudging from G3WAL, I tried using the same types of capacitors in the Coker VFO as I use in the Taunton's VFO hoping that this would improve the stability. It did! It is worth changing the two silver mica types to the round ceramic type coloured green or buff and also changing the capacitor linking to the varactor to a COG type. I can supply these three capacitors for £1 in stamps to include the postage.

Pitney experiences

As part of the Yeovil Club's activities to commemorate the 75th anniversary of the first amateur trans. Atlantic experiments in Feb. 1921 on 160m, Joe G3KSK, has heard several different US stations using his Pitney and a relatively simple antenna. I had thought it pretty unlikely that one would hear US stations in the UK with such a simple rig but I am glad to be proved wrong! It is surprising what one regenerative tuned circuit and an audio amp can achieve! Craig Douglas G0HDJ has also found that, when used with a normal transmitting type wire antenna, an antenna attenuator makes a great improvement to breakthrough problems from broadcast stations when trying to sniff out weak amateur stations.

Dates for your diaries!

There is just time to brush off your homebrew gear and get ready for the **Somerset Home-brew Contest**, which takes place on **March 30/31st 1996**. It is a multiband QRP contest being organised by the G - QRP Club and is open to all operators using any brand of homebrew equipment. Full details are in the Autumn 95 Sprat; first prize is a Taunton receiver for the band of the entrant's choice. All fully completed entries will go into a draw for a second prize which is a high performance Adjustable CW filter - this can be used with Somerset Range kits or with some other brand of receiver.

Don't forget that the 1996 **QRP Convention** is being held in the Digby Hall in Sherborne just a few miles East of Yeovil. The date is **May 19th**. There is an informal programme of events on the Saturday afternoon of the 18th with a dinner in the evening which is open to all. Activities for spouses are being planned so that those coming from afar can make it into an overnight break. Full details and assistance with bookings can be obtained from Peter Burridge on 01935 813054. Walford Electronics will be in attendance!

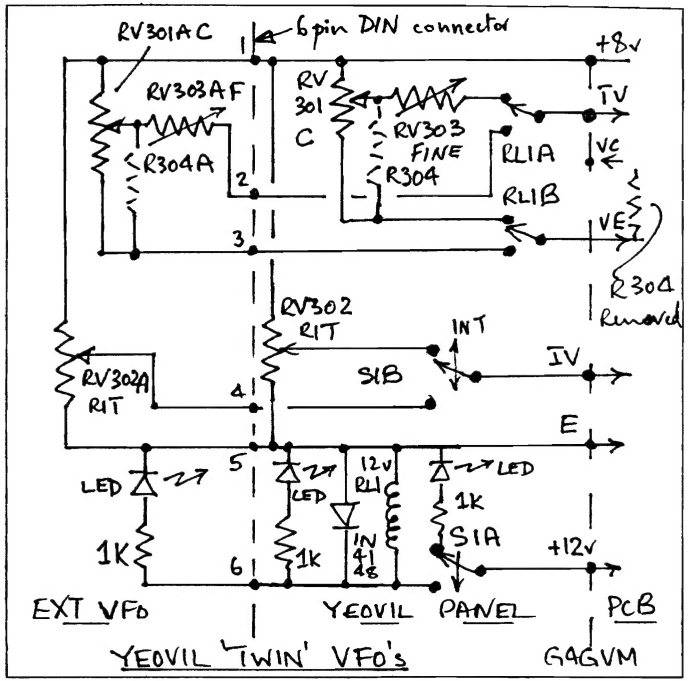
The **Construction Challenge**, at the QRP Convention, is always a jolly interesting event for anybody interested in construction. Plenty of opportunity for ingenuity! The task is to build a 80m antenna and receiver within a cube of 0.5 metre side. No more than 12 components are to be used and it has to operate without any DC power source, relying solely on electromagnetic radiation. The winner is the receiver producing the highest DC voltage into a 10 KOhm load when excited by a test transmitter putting 1 Watt CW into a short vertical antenna about 12 metres from the RX under test. Full details from Mike Smith on 01963 250594.

Computers!

I read in a recent article in an IEE Journal that one third of households in the UK have a computer in them already! It suggests that there must be many amateurs having PCs who might be interested in using the computer to control a rig or some item of test equipment. Any comments or suggestions most welcome!

'Twin VFOs'

Derek Alexander G4GVM has made a most interesting suggestion about rigs with varactor diode tuning. He says 'Of all the extra gimmicks (or what have you!) on the modern commercial rig, I think the second VFO is very useful. I usually use home brew equipment (more fun!) but when I do use my Icom 735 I often use the facility to find a clear channel whilst maintaining a QSO so that I can make a quick return. All of the Somerset Range kits use varactor tuning and it would seem to be an easy matter to switch from one set of tuning pots to another. I am particularly thinking of my Yeovil and the circuit illustration refers to this rig. In mine, I have added a 6 pin DIN socket on the rig's rear for connection to the second set of pots, with a control switch and relay added behind the rig's front panel. You can add LEDs to show which VFO is in use if you wish. The extra leads should be kept as short as practical, despite their only carrying DC, since small voltage drops in the leads can occur.'



In principle this approach can easily be applied to any rig with varactor tuning. The switching could also be controlled with a bandswitch if desired enabling cross band working for multi band rigs such as the Yeovil and Taunton! There is a small caveat to this in that the variable tuning voltage to the varactor usually

Workshop Practice by G7SDD

(This is a heavily 'Edited' piece derived from notes accompanying a very practical talk by Mike to YARC.)

Start with the tools you need!

Many people have the idea that to build anything, one needs a full blown workshop complete with every imaginable tool. **Wrong!** As long as you have an old table, and a few basic tools, you should be able to tackle most things. (Some aspects of metal bashing may prove somewhat difficult under these conditions, though!). So what is the minimum needed? The following list should enable construction of most kits or DIY development.

ESSENTIAL ITEMS

Drill and drill stand with bits 0.5 mm to 6.5 mm and a pin chuck
Soldering Iron, selection of bits, solder sucker, 60-40 solder,
Flush-cut wire cutters, fine point pliers, medium pliers,
Knife (not razor sharp), scriber (or 'pointy' tool), small centre punch,
Misc. screwdrivers
Tuning tools
Magnifier
Permanent marker pen

It is worth mentioning at this point, that it is false economy to buy cheap cutters, pliers and drill bits, so spend the most you can on these items. The reasons should be obvious. £4.00 cutters will last five minutes! Also, there's no need to buy purpose built wire strippers.... Its not too difficult to develop the knack of holding the wire cutters gently, and they will do the job just as well. Remember too, a very sharp knife, (such as a Stanley knife) will probably cut through more than you bargain for! Particularly the braid of coax or audio screened cable. Use an ordinary pocket knife instead. Besides, this can also double up as a means of de-burring holes you have drilled in boxes or panels.

USEFUL ITEMS (Particularly if DIY jobs intended to be done.)

Spot face cutter	(easier to handle than a drill bit)
Small G clamp	(holds laminate etc. to table whilst drilling and cutting)
Hacksaw	(full size one has more control)
Small vice	(drill bench vice best, but other options avail)
6" file	(de-burrs edge of laminate or chassis)
Nut drivers	(better than using pliers!)

Drilling.

Most DIY projects undertaken involve drilling holes in a die cast box or chassis and maybe in PCB's. The former usually presents few problems, as long as the drills are sharp and the drill position has been centre punched. (Just see where a 4 mm hole ends up if you don't centre pop the aluminium panel or die cast box first!) When drilling PCB's why is it that many people think that its better to run the very small drill slowly and carefully? Carefully, YES. Slowly. NO! If the drill is running at 3000 rpm (preferably faster), it is reluctant to bend, and zaps through the laminate without any problem. Don't use the small battery portable drills, as they tend to run slowly in order to increase the torque. As with any cutting operation, let the drill bit do the work. Don't force it to go through the board like a gimlet! Very few domestic drills will hold drill bits of the size used for PCB work. So use a pin chuck, which in turn goes into the main drill chuck. Don't even contemplate drilling whilst holding the drill freehand.... unless you have an unlimited stock of drills! A drill stand is essential, and can usually be picked up second hand at rallies or car boot sales. Finally, don't try drilling a PCB in near darkness. Steal the bedside lamp, or similar device, and get as much illumination on the work as possible.

Assembly

This may seem a somewhat obvious process, i.e. stick components in the holes and solder it all up. Well, its more or less done like that, but there are a few useful tips that may be considered worthwhile. Resistors and diodes are the easiest components to insert .... once the leads have been preformed to the appropriate pitch to suit the PCB holes. (Typically 0.4" or 0.5"). Once inserted, there's no need to bend the leads back along the track. A few degrees of bend will hold it in place whilst soldering, then once soldered, crop the excess wire at the limit of the solder fillet. Cropping AFTER soldering is good practice, as it minimises the shock on the component imparted by the cutters. This is particularly important when cutting transistor, diode or crystal leads. Capacitors are more of a problem, in that they vary so much in lead-out style. Axial lead capacitors can be treated like resistors, but radial lead types usually have to be lead-formed with more care to avoid stressing the lead-to-ceramic junction, or to avoid shorts to the ground plane. Lead-forming is simple

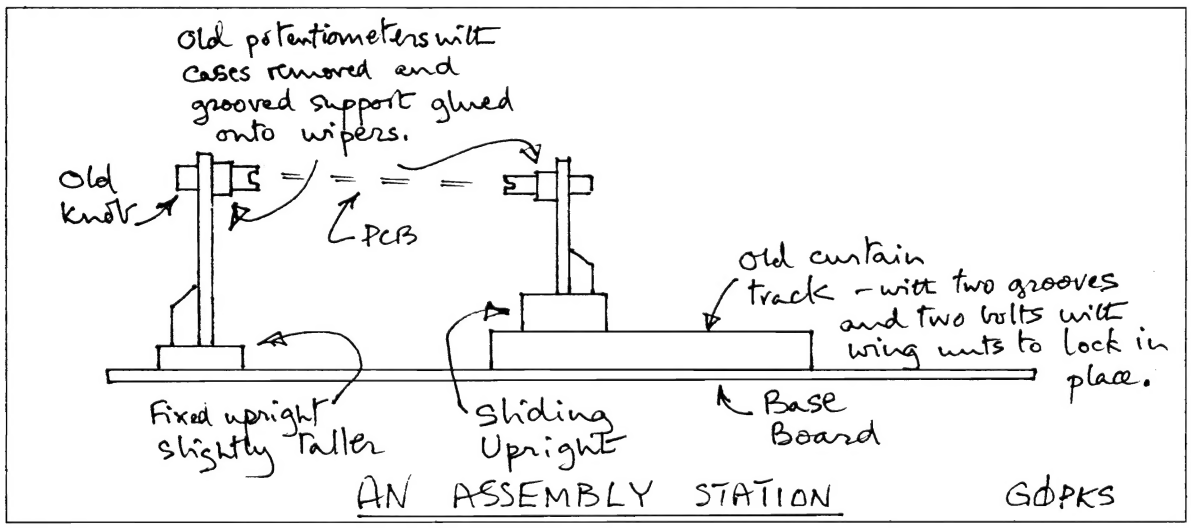
enough, but DOES require a good pair of fine point pliers .... and a bit of care. But once you've developed the knack, you'll wonder why building equipment ever seemed difficult. Finally, If the equipment is intended to be portable, e.g. RDF RX, where it may be bashed around a bit, it is worth anchoring larger components to the PCB with a small amount of contact adhesive.

De-soldering

Another black art..... so it seems. But one that can save many pennies by reclaiming components. Don't waste time trying to carefully melt the component-to-circuit board joint whilst trying to pull the component out of the board! All that happens is that the component overheats, the leads break, or you get burnt fingers! Some pundits advocate the use of Solder Wick, which soaks up the excess solder from the melted joint. I favour the fast attack approach, using a Solder Sucker. With a medium or fine point nozzle, this will suck up virtually all of the melted solder from the joint, leaving clear holes in the PCB. The component then drops out! (Assuming it hasn't had the leads bent over during assembly, of course. Again, plenty of heat and the right shaped bit, (particularly one that will hold a pool of solder), and the appropriate fast response on the trigger, is necessary, otherwise overheating will occur and negate your outlay for the solder sucker! Mike Smith G7SDD

An Assembly Station

Pete Norman, G0PKS, finds that the gadget sketched below to be very useful for holding and turning a PCB while it is being assembled. Old curtain track and old pots are the essential ingredients! The mounting board serves as a removable work bench with a soldering iron stand and a peg to restrain the solder reel. Prior to starting assembly, he recommends laying out capacitors, which are perhaps not so easily identified as resistors on a sheet of paper marked with their values; the capacitors are then held next to their 'label' with Sellotape or masking tape - it makes finding them again much easier and enables you to check that the kit supplier has sent all the parts required! (He had not! My apologies Pete. G3PCJ)



Smart Panels

Peter Barville G3XJS passes on his experience that a very good finish can be obtained on front panels by the use of 'Scotch 3M Spray Fix'. After spray painting the drilled control panel, and allowing it to dry thoroughly, he carefully applies the rub down lettering of the 'lettraset' type. He then sprays the whole panel with a couple of coats of the above product which gives a high degree of protection all over. Its available in artist shops.

He has also recently taken up sailboarding and has realised that the sailboard masts, being made of fibreglass, would make very nice aerial supports. He does recommend buying a new one, but his local club had some old (and out of fashion) one piece masts about 4.5 metres long at a nominal price. Most people now use a two piece mast. You might even operate maritime mobile at the same time!

My Bench!

I would add a pair of surgical tweezers to Mike's essential list above. Apart from these, the tools *always* on my bench are side cutters, two small screwdrivers, scalpel, smooth faced thin nosed pliers, small round and flat files, an indelible marker pen, a solder sucker and various plastic component trimming tools. As I do a fair amount of circuit building without any PCB, I keep several pieces of copper clad PCB on rubber feet with permanently connected supply and decoupling components. I build up circuits by soldering the earthy ends of grounded components direct to the PCB, with plenty of extra 10 nF decoupling capacitors for supply line anchorage points and other parts strung in free air between the earthed parts! Its simple & effective! G3PCJ

Evolution of a Signal Generator Design

The original brief was to design a simple signal generator covering about 1 to 30 MHz having a sinusoidal output and being easy to set up. Target price was under £50 since commercially made instruments are available for about £150. I had already decided that it was not to be cased and would not have a complicated mechanical dial assembly; the 3 digit counter is sufficiently cheap at £37 for this to be more attractive for those needing an accurate indication of frequency. Thus far it was easy going! Achieving stability, and adequate resolution without too many frequency ranges are where it becomes tricky! Within any one tuning range of a conventional oscillator, it is hard to achieve more than a 3:1 frequency coverage so conventional oscillators would need four ranges involving a lot of switching and probably markedly different output levels. Not attractive. Scheme two is a mixing scheme between a VFO running 10 to 20 MHz and a 10 MHz crystal oscillator providing three bands 10 MHz wide. Needs two fairly sharp filters and suffers badly from unwanted mixer high order products. Scheme three is for a VFO covering say 40 to 70 MHz and a 40 MHz crystal source to avoid the high order mixer products; only one filter needed but awful stability unless a phase locked loop with a low frequency variable master oscillator is used to stabilise the high frequency VFO. This needs to have the main range broken up into sections, using a variable division ratio but then the coverage on each frequency range would alter with changes in the division ratio . Scheme four is similar to three but with the HF VFO going in say 5 MHz steps and the 40 MHz signal being varied over 5 MHz to obtain the continuous coverage - again poor stability unless a second low frequency oscillator is used and multiplied up - getting awfully complex! Scheme five is solution three with a 'fractional N' variable divider - getting really very complex and might need a micro controller! Clearly it has got out of hand!

Start afresh with the thought that a sinusoidal output is not essential. Output signals from a digital VFO would probably have a 5 volt amplitude but this can easily be attenuated and the harmonics which make the fundamental into a square wave would all be at least twice the fundamental's frequency. Only if it was being used with a really wide band rig would the second and higher harmonics be within the receiver (or other band limiting circuit) passband. At first sight then this is not a problem and quite often low frequency audio amp tests are now done with square wave test signals anyway! It is also useful to have a source of square wave digital signals. The output frequency ranges can now easily be obtained with digital dividers, probably a mix of decade stages and smaller steps being easy. The HF digital VFO is easily made, operating to 40+ MHz, but can only easily achieve 2:1 frequency range so the output dividers need to be in 2:1 steps - this is very easy! If the HF VFO is locked to a low frequency digital VFO (actually a square wave variable clock source) using decade dividers in the feedback path to the phase locked loop's phase comparator, then these same dividers provide a convenient pick off point for further output range dividers. Output frequency coverage can now be down to very low frequencies limited only by how many decade dividers it is sensible to install for most people's needs and would actually be determined by what comes in standard ICs. The general block diagram then looks something like that shown below. This is about scheme number ten! The only snag that I can see, is that the variable dial calibration would be in terms of a multiplying factor from the bottom edge rather than an actual frequency or decade range etc. I think this is outweighed by the circuit simplicity and easy of setting up. I would love to have your thoughts please. Tim Walford G3PCJ